CLAIMS:

What is claimed is:

1. An electronic watermarking system, for embedding additive information in digital data, for which one frame is defined as including N samples extracted from digital data and a current frame is defined as a frame that is overlapped by M samples ($0<M\leqq N/2$) of a preceding frame, comprising:

(1) a frequency domain transformation unit, for multiplying a frame extracted from digital data by a window function, and for using the results to perform a Fourier transform and thus obtain a frequency component for said digital data;

(2) a frequency domain embedding unit, for employing bit information for additive information, and a frequency band for said frequency component to change the amplitude of said frequency component in said digital data obtained by said frequency domain transformation unit;

(3) a time domain transformation unit, for performing an inverse Fourier transform to return, to a time domain signal, said frequency component whose amplitude has been changed by said frequency domain embedding unit; and

(4) an additive information embedding frame generator, for multiplying, by a window function, said time domain signal obtained by said time domain transformation unit, and for superimposing overlapped

frames to generate a frame wherein said additive information is embedded.

2. An electronic watermarking system according to claim 1, wherein, to change said amplitude of said frequency component of said digital data, said frequency domain embedding unit (2) employs bit information for additive information and the values of a mask, determined in advance in accordance with a frequency band, with which said frequency component is to be increased or decreased.

3. An electronic watermarking system according to claim 2, wherein the values of said mask corresponding to all the frequencies included in one frequency band are equalized.

4. An electronic watermarking system according to claim 2 or 3, wherein, as the frequency increases, the width of said frequency band is extended.

5. An electronic watermark detection system, for detecting additive information embedded in digital data, comprising:

(1) a frequency domain transformation unit, for multiplying a frame extracted from digital data by a window function, and for performing a Fourier transform to obtain a frequency component from said digital data;

(2) an amplitude storing unit, for obtaining amplitudes for said frequency components acquired by said frequency domain transformation unit, and for storing a

number of said amplitudes that equals a predetermined frame count;

(3) a cycle synchronization unit, for employing an amplitude value stored by said amplitude storing unit to designate a bit detection start frame; and

(4) a bit detector, for detecting bit information from embedded additive information beginning at said bit detection start frame obtained by said cycle synchronization unit.

6. An electronic watermark detection system according to claim 5, wherein said frequency domain transformation unit (1) uses the shorter length of said frame than the length when said additive information is embedded.

7. An electronic watermark detection system according to claim 5, wherein, in order to designate said bit detection start frame by referring to said amplitude values, said cycle synchronization unit (3) employs calculation results obtained by using the values of a mask that defines, in advance, a frequency component increase or decrease.

8. An electronic watermarking method, for embedding additive information in digital data, whereby one frame is defined as including N samples extracted from digital data, and a current frame is defined as a frame that is overlapped by M samples ($0<M\leq N/2$) of a preceding frame, comprising the steps of:

(1) extracting one frame as a current frame from

digital data;

(2) multiplying said current frame by a window function;

(3) performing a Fourier transform for the resultant current frame to obtain a frequency component for said current frame;

(4) changing an amplitude of said frequency component in accordance with bit information for additive information;

(5) performing an inverse Fourier transform for the resultant frequency component;

(6) multiplying, by said window function, said frequency component obtained using said inverse Fourier transform; and

(7) adding an (N-M)-th sample, from the end of a preceding frame processed in the same manner as said steps (1) to (6), to an M-th sample, from the head of said current frame processed at said step (6), and generating one new frame including N samples.

9. An electronic watermarking method according to claim 8, wherein, at said step (4) of changing said amplitude of said frequency component, said amplitude is changed by employing bit information for additive information and the values of a mask, determined in advance in accordance with a frequency band, with which said frequency component is to be increased or decreased.

10. An electronic watermarking method according to claim 9, wherein the values of said mask corresponding to all

the frequencies included in one frequency band are equalized.

11. An electronic watermarking method according to claim 9 or 10, wherein, as the frequency increases, the width of said frequency band is extended.

12. A method for detecting additive information embedded in digital data comprising the steps of:

(1) extracting one frame including N samples from digital data;

(2) multiplying said frame by a predetermined window function;

(3) performing a Fourier transform for said resultant frame to obtain a frequency component of said frame;

(4) storing a value for an amplitude of said frequency component;

(5) calculating an optimal start frame for additive information detection when the stored amplitude value reaches a predetermined value through said steps (1) to (4); and

(6) detecting bit information for said additive information beginning at said start frame.

13. A method according to claim 12, wherein, at said step (1) of extracting one frame, uses the shorter length of said frame than the length when said additive information is embedded.

14. A method according to claim 12, wherein, at said step (5) of calculating the optimal start frame, calculation results obtained by using the values of a mask, which define, in advance, a frequency component increase or decrease, are employed in order to designate said bit detection start frame by referring to said amplitude value.

15. An electronic watermarking method for embedding in digital data N bits ($N \geqq 1$) of additive information comprising the steps of:

(1) reading sample values, from digital data, up to an R-th sample ($R \geqq 1$);

(2) reading sample values, from said digital data, following an (R+1)-th sample;

(3) changing said sample values following said (R+1)-th sample in accordance with bit information for additive information; and

(4) adding together the values up to said R-th sample in said digital data and the values following said (R+1)-th sample, changed in accordance with said bit information for said additive information.

16. An electronic watermarking method for embedding in digital data N bits ($N \geqq 1$) of additive information comprising the steps of:

(1) reading a sample value from digital data;

(2) starting to change said sample value in accordance with bit information for additive information,

excluding a head bit of said additive information; and

(3) using said changed sample value to generate new digital data.

17. An electronic watermarking method for embedding in digital data N bits ($N \geqq 1$) of additive information comprising the steps of:

(1) reading a sample value from digital data;

(2) changing said sample value in accordance with bit information for additive information;

(3) adding noise at random to said changed sample value; and

(4) using said changed sample value to generate new digital data.

18. An electronic watermarking method for embedding in digital data N bits ($N \geqq 1$) of additive information comprising the steps of:

(1) reading a sample value from digital data;

(2) changing said sample value in accordance with bit information for additive information, and setting at random a case wherein a change is not required; and

(3) using either the changed sample value or the unchanged sample value to generate new digital data.

19. An electronic watermarking method for embedding in digital data N bits ($N \geqq 1$) of additive information comprising the steps of:

(1) changing digital data by superimposing,

inserting, deleting or shifting a specific sample of said digital data;

(2) reading a sample value from said digital data;

(3) changing said sample value in accordance with bit information for additive information; and

(4) using said changed sample value to generate new digital data.

20. An electronic watermarking method for embedding in digital data N bits ($N \geqq 1$) of additive information comprising the steps of:

(1) expanding or compressing digital data along a time axis;

(2) reading a sample value from said digital data;

(3) changing said sample value in accordance with bit information for additive information; and

(4) using said changed sample value to generate new digital data.

21. An electronic watermarking method for embedding in digital data N bits ($N \geqq 1$) of additive information comprising the steps of:

(1) reading a sample value from said digital data;

(2) changing said sample value in accordance with bit information for additive information;

(3) using said changed sample value to generate new digital data; and

(4) expanding or compressing said new digital data along a time axis.

22. An electronic watermarking method according to claim 20 or 21, wherein an expansion/compression rate for the digital data does not exceed 1%.

23. An electronic watermarking method for embedding in digital data N bits ($N \geqq 1$) of additive information comprising the steps of:

(1) re-sampling digital data at a sampling frequency r' and reading a sample value from said digital data;

(2) changing said sample value in accordance with bit information for additive information; and

(3) sampling said changed sample value at the original sampling frequency r to generate new digital data.

24. An electronic watermarking method for embedding in digital data N bits ($N \geqq 1$) of additive information comprising the steps of:

(1) sampling digital data at a sampling frequency r' and reading a sample value from said digital data;

(2) obtaining a change in said sample value in accordance with bit information for additive information;

(3) re-sampling said change at a sampling frequency r for the original digital data; and

(4) adding said re-sampled change to said original digital data to generate new digital data.

25. A computer-readable recording medium on which a program for embedding additive information in digital data is stored, said program defining one frame as

including N samples extracted from digital data and defining a current frame as a frame that is overlapped by M samples ($0<M\leqq N/2$) of a preceding frame, and permitting a computer to execute:

(1) a frequency domain transformation function, for multiplying a frame extracted from digital data by a window function, and for using the results to perform a Fourier transform and thus obtain a frequency component for said digital data;

(2) a frequency domain embedding function, for employing bit information for additive information, and a frequency band for said frequency component to change the amplitude of said frequency component in said digital data obtained by said frequency domain transformation function;

(3) a time domain transformation function, for performing an inverse Fourier transform to return, to a time domain signal, said frequency component whose amplitude has been changed by said frequency domain embedding function; and

(4) an additive information embedding frame generation function, for multiplying, by a window function, said time domain signal obtained by said time domain transformation function, and for superimposing overlapped frames to generate a frame wherein said additive information is embedded.

26. A computer-readable recording medium on which a program for detecting additive information embedded in digital data is stored, said program permitting a

computer to execute:

(1) a frequency domain transformation function, for multiplying a frame extracted from digital data by a window function, and for performing a Fourier transform to obtain a frequency component from said digital data;

(2) an amplitude storing function, for obtaining amplitudes for said frequency components acquired by said frequency domain transformation function, and for storing a number of said amplitudes that equals a predetermined frame count;

(3) a cycle synchronization function, for employing an amplitude value stored by said amplitude storing function to designate a bit detection start frame; and

(4) a bit detection function, for detecting bit information from embedded additive information beginning at said bit detection start frame obtained by said cycle synchronization function.

27. An article of manufacture comprising a computer usable medium having computer readable program code means embodied therein for causing detection of additive information embedded into digital data, the computer readable program code means in said article of manufacture comprising computer readable program code means for causing a computer to effect the steps of claim 12.

28. An electronic watermarking system for embedding additive information into digital data, said system comprising:

a frequency domain transformation unit for multiplying a current frame extracted from said digital data by a window function, and for using the results of the multiplication to obtain a frequency component for said digital data, wherein a frame in said system is defined as including a plurality of samples extracted from the digital data, and a current frame in said system is defined as a frame that is overlapped by at least one sample from said plurality of samples of a preceding frame;

a frequency domain embedding unit for employing bit information for additive information, and for employing a frequency band for said frequency component in changing the amplitude of said frequency component in said digital data obtained by said frequency domain transformation unit;

a time domain transformation unit for performing an inverse transform to return said frequency component whose amplitude has been changed by said frequency domain embedding unit to a time domain signal; and

an additive information embedding frame generator for multiplying said time domain signal obtained by said time domain transformation unit by the window function, and for superimposing overlapped frames to generate a frame wherein said additive information is embedded.

29. An electronic watermarking system according to claim 1, wherein in changing said amplitude of said frequency component of said digital data, said frequency domain

embedding unit employs bit information for additive information and the values of a mask determined in advance in accordance with a frequency band.

30. An electronic watermarking system according to claim 29, wherein the values of said mask corresponding to frequencies included in one frequency band are equalized.

31. An electronic watermark detection system comprising:

a frequency domain transformation unit for multiplying a frame extracted from digital data by a window function, and for performing a transform to obtain a frequency component from said digital data, said system for detecting additive information embedded in the digital data;

(2) an amplitude storing unit for obtaining amplitudes for said frequency components acquired by said frequency domain transformation unit, and for storing a number of said amplitudes that equals a predetermined frame count;

(3) a cycle synchronization unit for employing an amplitude value stored by said amplitude storing unit to designate a bit detection start frame; and

(4) a bit detector, for detecting bit information from embedded additive information beginning at said bit detection start frame obtained by said cycle synchronization unit.

32. An electronic watermark detection system according

to claim 31, wherein said frequency domain transformation unit (1) uses the shorter length of said frame than the length when said additive information is embedded.

33. An electronic watermarking method for embedding additive information into digital data, said method comprising:

defining a frame as including a plurality of samples extracted from the digital data;

defining a current frame as a frame that is overlapped by at least one of said plurality of samples of a preceding frame;

extracting one frame as a current frame from digital data;

multiplying said current frame by a window function;

performing a transform for the resultant current frame to obtain a frequency component for said current frame;

changing an amplitude of said frequency component in accordance with bit information for additive information;

performing an inverse transform for the resultant frequency component;

multiplying, by said window function, said frequency component obtained using said inverse transform;

adding an additional sample, from the end of a preceding frame processed in the same manner as in said steps of extracting, multiplying, performing, changing,

performing and multiplying to a previous sample from the head of said current frame processed at said step of multiplying, and;

generating one new frame including the plurality of samples.

34. An article of manufacture comprising a computer usable medium having computer readable program code means embodied therein for causing additive information to be embedded into digital data, the computer readable program code means in said article of manufacture comprising computer readable program code means for causing a computer to effect the steps of claim 33.

35. A method for detecting additive information embedded in digital data comprising the steps of:

extracting one frame including a plurality of samples from the digital data;

multiplying said one frame by a predetermined window function to obtain a resultant frame;

performing a transform for said resultant frame to obtain a frequency component of said resultant frame;

storing a value for an amplitude of said frequency component;

calculating an optimal start frame for additive information detection when the stored amplitude value reaches a predetermined value through said steps of extracting, multiplying, performing and storing; and

detecting bit information for said additive information beginning at said start frame.

36. An article of manufacture comprising a computer usable medium having computer readable program code means embodied therein for causing additive information to be embedded into digital data, the computer readable program code means in said article of manufacture comprising computer readable program code means for causing a computer to effect the steps of claim 35.

37. An article of manufacture comprising a computer usable medium having computer readable program code means embodied therein for causing additive information to be embedded into digital data, the computer readable program code means in said article of manufacture comprising computer readable program code means for causing a computer to effect the steps of claim 8.

38. A computer program product comprising a computer usable medium having computer readable program code means embodied therein for causing additive information to be embedded into digital data, the computer readable program code means in said computer program product comprising computer readable program code means for causing a computer to effect the functions of the system in claim 1.

39. A computer program product comprising a computer usable medium having computer readable program code means embodied therein for causing detection of additive information embedded into digital data, the computer

readable program code means in said computer program product comprising computer readable program code means for causing a computer to effect the functions of the system in claim 5.